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Deforestation And Environmental Degradation: A Study With Special Reference To Northern And Northeast Mountain Regions Of India

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Abstract: Deforestation is a significant contributor to global greenhouse gas emissions. Environmental degradation is driven by emissions of greenhouse gases, including carbon dioxide (CO_2), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and by deforestation. This paper aims to achieve two main objectives. Firstly, it seeks to assess the extent of deforestation in the Northern and Northeastern regions of India. Secondly, it aims to analyze the environmental degradation resulting from deforestation across various regions of India, with a particular focus on the Northern and Northeastern areas.

The study relies on secondary data collected from multiple sources, covering the period from 2001 to 2020 for empirical validation. The Environmental Kuznets Curve (EKC) hypothesis is employed to measure environmental degradation. The paper utilizes the least square dummy variable (LSDV) model to test the existence of an inverted U-shaped EKC in different regions of India. The empirical findings confirm an inverted U-shaped Environmental Kuznets Curve (EKC) in the Northern and Northeastern regions of India, indicating that environmental degradation is occurring due to deforestation.

Keywords: deforestation • environmental kuznets curve • environmental degradation • least square dummy variable model

Introduction

The degradation of the environment occurs due to high economic growth generated through industrial development (Li et al., 2021) and the expansion of greenhouse gas emissions (Yang et al., 2021). The greenhouse gas emission consists of carbon dioxide (CO_2), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2) (Rudra and Chattopadhyay, 2018). The high economic growth brings social, economic and environmental challenges in India (Solarin et al., 2017). In the 1990s, India entered into a full phase of LPG (Liberalization, Privatization and Globalization) and emphasized increasing production and consumption activities which led to environmental deterioration (Pata and Kumar, 2021).

The environmental Kuznets Curve (EKC) hypothesis is used to measure environmental degradation (Grossman and Krueger, 1991). The EKC hypothesis shows an inverted U-shaped relationship between economic growth and environmental degradation. There are many studies focused on the relationship between economic growth (income) and CO_2 emissions using the EKC (Environmental Kuznets Curve) hypothesis (Coondoo & Dinda., 2008, Shafik, 1994, Dinda, 2004). On the other hand, many other studies used water quality indicators (say, lead, arsenic, nickel etc) for measuring environmental degradation and concluded

contrasting shapes and peaks of the EKC (Beede and Wheeler, 1992).

Deforestation generates CO_2 emissions, which is nearly about 17- 20% of total global greenhouse gas emissions (Basu and Basu, 2023). As a result of such environmental degradation or deterioration of the ecological environment, extreme climatic events such as floods, tsunamis and fire disasters occurred in India, Pakistan, Australia and Russia in recent years (Dagar et al., 2021). Deforestation has been caused by various anthropogenic and natural factors like agricultural land expansion, illegal logging, urbanization, mining activities, and economic development including infrastructure development, trade, and poor governance.

It is important to mention some studies relating to deforestation and economic growth using the EKC hypothesis for measuring environmental degradation in Asia, Latin America and Africa (Ehrhardt-Martinez et al., 2002; Barbier and Burgess, 2001; Bhattarai and Hamming, 2002; Culas, 2007; Zambrano-Monserrate et al., 2018; Cropper and Griffiths, 1994; Marquart-Pyatt, 2004). Some other studies showed an inverted U-shaped EKC for deforestation in Iran (Esmaeili and Nasrnia, 2014), Indonesia (Waluyo and Terawaki, 2016), and Pakistan (Ahmed and Long, 2012).

In the Indian context, Rudra and Chattopadhyay (2018) examined environmental degradation using some selected air pollutants, CO_2, SO_2 NO_2 and PM10 in some selected states of India and utilized the EKC hypothesis for measuring environmental degradation, and found that the inverted U- shaped EKC is valid for Kerala and Punjab while other states like West Bengal, Bihar, Maharashtra and Uttar Pradesh followed U- shaped EKC. There are some other studies in India relating to the inverted U-shaped EKC hypothesis (Usman et al., 2019; Ahmed and Wang, 2019; Rana and Sharma, 2019; Sanu, 2019).

Against the above backdrop, the objectives of the study are as follows. Firstly, is to examine the amount of deforestation in the Northern and North-eastern regions of India. Secondly, is to investigate environmental degradation due to deforestation in various regions of India in general and Northern and Northeast regions of India in particular by the Environmental Kuznets Curve (EKC). The study is chosen for two reasons. Firstly most of the studies emphasized air quality and water quality as the major sources of environmental degradation and very few studies are available on deforestation as a measure of environmental degradation. Secondly, most of the studies are available on either country-specific or cross-country analysis but a few amounts of studies are at the regional level in India.

Measurement of Environmental degradation

Environmental degradation is measured by the inverted U-shaped Environmental Kuznets Curve (EKC) hypothesis (Shahbaz et al., 2013; Ulucak et al., 2020). By inverted U-shaped EKC means initially environmental degradation started rising with the rise in per capita income of the country and after reaching its maximum then started to decline by preserving the environment with a further rise in per capita income, shown in Fig.(1).

Materials and Methods

Study area: The paper covers the Northeastern and Northern regions of India. In Northeast India, the selected states are Assam, Manipur, Arunachal Pradesh, Meghalaya, Sikkim, Mizoram, Tripura, and Nagaland while two Northern mountain regions are Uttarakhand and Himachal Pradesh. The other regions of India like the Eastern region (West Bengal, Orissa, Jharkhand and Bihar), Southern region (Andra Pradesh, Karnataka, Kerela and Tamil Nadu) and Central region (Chhattisgarh, Madhya Pradesh and Maharashtra) are selected for

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empirical analysis. Map of the study area is given in Fig.(2).

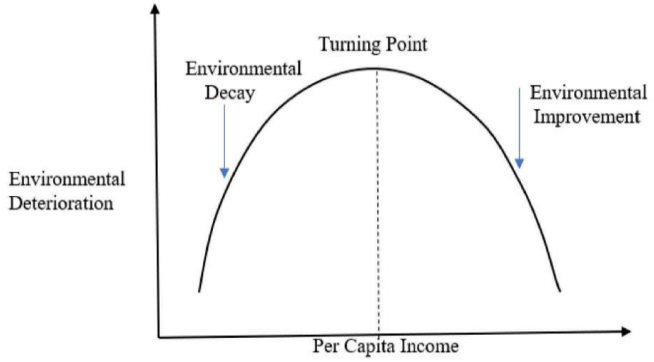

Fig.1. Environmental Kuznets Curve

Data

The paper is based on secondary data collected from various sources like the Forest Survey of India (FSI) and Global Forest Watch, 2022. Data covers from 2001-2020 for empirical analysis. The paper has utilized the Least Square Dummy Variable (LSDV) model to examine the environmental degradation due to deforestation. Four variables are taken into consideration. Tree cover loss is assumed to be taken as a proxy for deforestation which is known as a dependent variable. The independent variables are per capita net state domestic product (NSDP), the square of per capita NSDP and rural population (% of the total population) along with the state as dummy variables.

Theoretical relationship between economic growth and deforestation

The quadratic model is used to estimate the EKC hypothesis. This model is confirmed by Grossman and Krueger (1991,1995), Katz(2015), Bhattaria and Humming(2001). The quadratic model is specified as follows:

$(TCL_{it}) = \alpha_i + \beta_1 \text{ Log } (NSDP_{it}) + \beta_2 [\text{Log}(NSDP_{it})]^2 + \beta_3 P_{it} + \beta_4 D_{it} + u_{it}$ ----------(1)

Where i= 1,2,3 …….n is states and t= year; TCL_{it} represents tree cover loss; αi is the intercept term; $NSDP_{it}$ is the net state domestic product per capita; P_{it} is rural population (% of total population) of states. D_{it} is state dummies. β_1, β_2 and β_3 are the coefficients to be estimated and u_{it} is the error term. If $\beta_1 < 0$; and $\beta_2 > 0$ there exists a U-shaped EKC relationship. On the other hand, if $\beta_1 > 0$; and $\beta_2 < 0$ then it reveals an inverted U-shaped EKC relationship.

Result and discussion

Deforestation in Northern and Northeast regions of India

The amount of deforestation in the Northern and Northeast regions of India is shown in Table 1. It is observed that the deforestation in Northeast Indian states is alarmingly higher than that of Northern States of India (Table 1). In the Northeast Indian states, the state of Assam reached the highest deforestation and the state of Meghalaya has the lowest deforestation (Table 1). There are some important drivers for deforestation in the Northeast region of India. One of them is the expansion of commercial plantations for crops like tea and rubber, the other is the logging of timber and fuel wood. Besides, the shifting cultivation and infrastructure development is another important contributor to deforestation in the Northeast region of India.

Table 1: Deforestation (in thousand hectare) in Northern and Northeast regions of India (2001-2020)

State	Deforestation(in thousand hectare)
Assam	306
Mizoram	293
Arunachal Pradesh	251
Nagaland	248
Manipur	226
Tripura	126
Meghalaya	100
Sikkim	168
Himachal Pradesh	5.02
Uttarakhand	18.7

Source : Global Forest Watch,2022

Fig 2. Map in the study area

Environmental degradation by LSDVregression model

Table 2-Table 6 show the results of the LSDV model for the Northeast, Northern, Eastern, Southern, and Central regions respectively. For the Northeast region of India, it is observed that the estimated coefficient of Log NSDP is positive and significant while the coefficient of square value of Log NSDP is negative and significant, which shows that there prevails the inverted U-shaped EKC hypothesis (Table 2).

Table 2. Result of LSDV model for Northeastern region in India

Variables	Coefficient	Standard Error	t-values	Probability
% of RP	0.043	0.012	3.45	0.001
LogNSDP	41.03	8.50	4.83	0.000
Sq. LogNSDP	-1.903	0.381	-4.99	0.000
D_1(Arunachal Pradesh)	0.518	0.273	1.89	0.060
D_2 (Assam)	1.176	0.182	6.43	0.000
D_3(Manipur)	1.009	0.221	4.55	0.000
D_4 (Meghalaya)	0.494	0.174	2.83	0.005
D_5(Mizoram)	0.861	0.639	1.35	0.180
D_6 (Nagaland)	0.714	0.175	4.06	0.000
D_7 (Sikkim)	-5.57	0.281	19.85	0.000
Constant	-59.11	18.56	-3.18	0.002
N= 160; F(3,156) = 41.19; R^2 = 0.584 The reference state is Tripura				

Source: Author's calculation

This further means that deforestation results in environmental degradation in the Northeast region of India. For the Northern region of India, the estimated coefficient of Log NSDP is positive and significant and the estimated coefficient of the square of Log NSDP is negative and significant (Table 3). This means that there exists an inverted U-shaped EKC hypothesis further implying that deforestation harms the environment in the Northern region of India. The result of the LSDV model for the Eastern region does not confirm the EKC hypothesis. Because the estimated coefficient values of Log NSDP and the square of Log NSDP are not significant (Table 4). For the Southern region, the estimated coefficient value of Log NSDP is negative and significant and the estimated coefficient of square of Log NSDP is positive and significant implying that the U-shaped EKC hypothesis is justified. This result shows that deforestation does not harm the environment (Table 5). On the other hand, the EKC hypothesis does not hold in Central India (Table 6).

Table 3. Result of LSDV model for Northern region in India

Variables	Coefficient	Standard Error	t	Probability
% of RP	0.108	0.015	7.10	0.000
LogNSDP	43.53	14.09	3.09	0.004
Sq. LogNSDP	-1.960	0.625	-3.13	0.003
D1(Uttarakhand)	-16.02	6.89	-2.32	0.026
Constant	-226.82	79.12	-2.87	0.007
N= 40; F(3,36) = 27.79; R^2 = 0.565 Reference state is Himachal Pradesh				

Source : Author's calculation

Table 4. Result of LSDV model for Eastern region in India

Variables	Coefficient	Standard Error	t	Probability
% of RP	-0.217	0.0206	-10.53	0.000
LogNSDP	13.58	28.78	0.47	0.639
Sq. LogNSDP	-0.556	1.338	-0.42	0.679
D_1 (Jharkhand)	0.881	1.311	0.67	0.504
D_2 (Orissa)	6.71	3.29	2.04	0.047
Constant	-69.41	154.60	-0.45	0.653
N=60; F(3,56) = 39.45; R^2 = 0.5567 Reference state is West Bengal				

Source : Author's calculation

Table 5. Result of LSDV model for Southern region in India

Variables	Coefficient	Standard Error	t	Probability
% of RP	0.0284	0.0067	4.23	0.000
Log NSDP	-27.16	11.99	-2.27	0.026
Sq. Log NSDP	1.242	0.530	2.34	0.022
D1(Andrapradesh)	-1.143	0.791	-1.45	0.153
D2 (Karnataka)	-0.582	0.570	-1.02	0.311
D3 (Kerala)	-1.097	0.902	-1.22	0.228
Constant	153.69	67.38	2.28	0.025
N= 80; F(3,76) = 38.66; R^2 = 0.484 Reference state is Tamil Nadu				

Source : Author's calculation

Table 6. Results of LSDV model for central India region in India

Variables	Coefficient	Standard Error	t	Probability
% of RP	0.050	0.013	3.82	0.000
Log NSDP	2.001	6.633	0.30	0.764
Sq. Log NSDP	-0.048	-0.304	-0.16	0.873
D1 (Chhattisgarh)	3.750	2.324	1.61	0.112
D2 (Madhyapradesh)	0.996	1.643	0.61	0.547
Constant	-12.66	35.76	-0.35	0.725
N= 60; F(3,56) = 26.96; R^2 = 0.4214 Reference state is Maharastra				

Source : Author's calculation

Conclusions and policy suggestions

The paper reaches several key conclusions. Firstly, deforestation is more prevalent in the Northeast region compared to the Northern region of India. Within the Northeast, Assam has the highest rate of deforestation, while Meghalaya has the lowest. Secondly, deforestation has a more severe impact on the environment in the Northeast and Northern regions than in other parts of India. The paper

emphasizes the need for effective implementation of forest regulations to ensure sustainable forest management and control deforestation. In the Northeast, particular attention should be given to enforcing the National Forest Policy and Forest Conservation Act, promoting community-based forestry initiatives, and encouraging sustainable agricultural practices.

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